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First an Egg, Then a Man

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Science and Man

THE CULTIVATION of tissue cells outside the body has been one of the landmarks of experimental biology. Known for 60 years, the technique has come to practical use outside the research laboratory only in the past decade. Its main application is still for the routine production of viruses to make vaccines.

But diagnostic applications are now of growing importance: cell cultures from patients are used for decisive chromosome studies in cases of suspected mongolism or Klinefelter's disease, (maldevelopment of the testes).

Other tests could detect certain genetic diseases of metabolism. As we learn to make cell cultures from the early fetus, we gain a scientific resource for rational decisions about human reproduction. Whether to abort a pregnancy will depend in part on whether the result is expected to be a human infant or a tragic monster.

By reducing the stakes in a pregnancy, such techniques will relieve many prevalent anxieties, making birth a little less like Russian roulette. They will undoubtedly motivate many prudent couples to attempt a pregnancy otherwise too risky for thoughtful choice.

Cell culture has still to complete its most important contribution to human understanding, and this will undoubtedly be in the field of differentiation, where it has so far served to raise more precise new questions than answers to old ones.

THE MAIN issue is how the single egg cell develops into a complicated organism with so many interdependent differentiated tissues and organs. By the techniques of tissue culture, it can be shown that cells of, say, the thyroid gland, the kidney or the brain retain their individuality when grown in separate culture.

Differentiation of cell type is then in large part an inherent quality of the cell, which is retained even when different cells are sustained in the same environment. But other evidence continues to support the ancient rule that all the cells have the same genetic blueprints, the same set of DNA information in the nuclei.

We must then answer two seemingly paradoxical questions. How do cells with the same DNA sustain their unique tissue differentials, i.e., remain nerve-like or kidney-like once formed? And how are these differentials established so precisely in the first place?

Is it necessary to point out the practical importance of new knowledge in such a field? To give the crudest example, visualize the impact on human life if a new heart could be induced to grow in place, to substitute for a weary old one.

The campaign toward this triumph is well under way: it is the central challenge of contemporary biology, founded on the research that led to the solution of the genetic code and the basic biochemical mechanisms of heredity. Considering the certain payoffs of another 10 or 20 years of fundamental biochemical research, it is ironic that there should be so much talk of a "reasonable plateau" of such research at its most crucial, ascendant moment in history.

A PLAUSIBLE general theory of differentiation can already be outlined, mainly from work with microbes just starting to be transposed to animal and ultimately human development. The DNA information is replicated rather faithfully and transmitted uniformly to every cell.

Genetic code research shows, however, that the readout of the DNA goes through several steps. First, a "transcription" of DNA segments into RNA "messages." Then, the "translation" of an RNA message into the amino acid sequence of a protein. Finally, the release of the protein into the cell, where it may then interact with other proteins and other cell products, or feed back to control the earlier steps of readout of other messages.

The crucial steps are the transcription and the translation. Recent evidence suggests that transcription is the most importantly vulnerable control step in microbes, but translation may have to be considered in higher organisms.

Recent tissue culture research has also shown that dispersed cells rarely show their specialized capacities to the same advantage as similar cells grown in communities. In some cases, the interactions between cells can be traced to soluble cell products that accumulate in the culture fluid.

In others, the evidence supports a more immediate cell-to-cell interaction via their surface contacts. How these interactions eventually signal the machinery of the genetic code inside the cell is one of the most exciting avenues of contemporary research in cell biology.